June 2, 1942. C. H. KIDWELL 2,284,746

GRINDING AND CLASSIFYING DEVICE

Filed March 4, 1939

Fig. 1

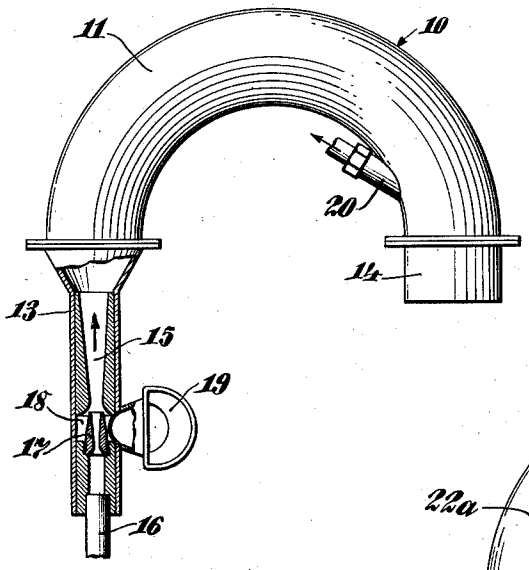


Fig. 2

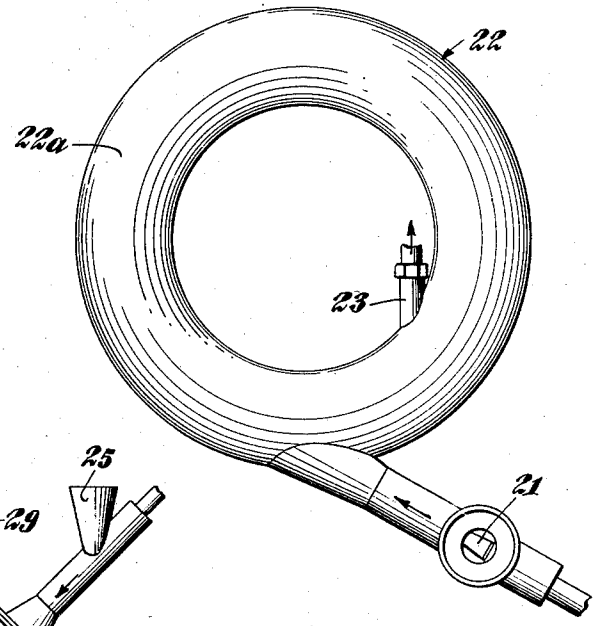
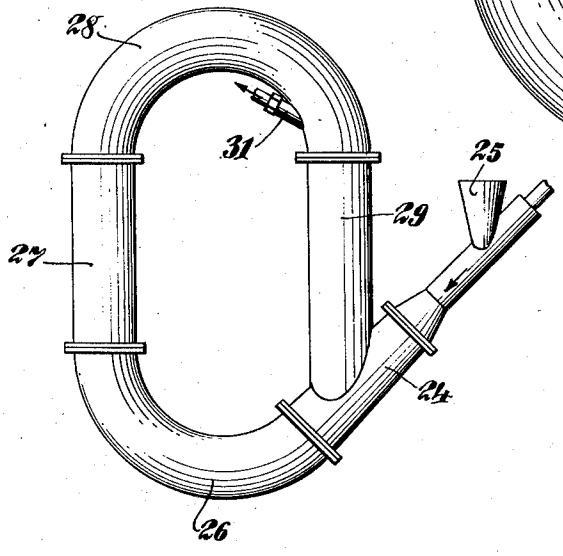


Fig. 3



INVENTOR.
Cleo Harold Kidwell,
BY Hoguet, Neary & Campbell,
ATTORNEYS

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GRINDING AND CLASSIFYING DEVICE

Cleo Harold Kidwell, Short Hills, N. J.

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8 Claims. (Cl. 83—46)

The present invention relates to apparatus for reducing or grinding materials, and more particularly to an improved form of grinding apparatus whereby a greater uniformity of particle size in the finished product is attainable.

The development of this art has been in the main concerned with improvements in methods of reducing over-sized and irregularly sized materials in grinding mills, and to this end it has been discovered that particles of material to be treated may be suspended in a carrying fluid medium and introduced into a reducing mill having a substantially curved tubular grinding chamber. The velocity is sufficient to cause the suspending fluid stream to flow in substantially double helical streams in the tubular chamber, these currents tending to entrain the particles therein to produce reduction by the attrition thereof.

In certain grinding operations now carried out with existing forms of mills employing the double helical stream flow effect above referred to, it is found that there frequently occurs a carrying over or passing of over-sized particles. This either requires longer grinding in the mill or a separating operation by means of which the oversized particles are separated from the final product.

I have discovered that this objectionable condition whereby over-sized particles are carried over into the final product may be avoided by means of a certain definite mill structure in which the discharge or outlet from the mill is located on the inner periphery of a curved portion of the tube. This result obtains from the fact that the double helical flow effect produced in the above described grinding devices results in the tendency of the moving material to remain in the outer portions (radially speaking) of the described curved tubular grinding chamber. Hence by locating means for removing the treated material from the mill on the inner periphery of the curved portion, a product is achieved, characterized by a controlled maximum particle size substantially finer than heretofore available.

An object of the invention, accordingly, is to provide an improved form of grinding device whereby a product is attained which is characterized by controlled uniformity of particle size substantially finer than has been heretofore available.

A further object of the invention is to provide a grinding device which may be kept in continual operation, simultaneously introducing untreated material into the grinding chamber and withdrawing that portion of the material which has been reduced to the desired particle size.

A further object of the invention is to provide a grinding mill formed to produce the double helical flow, and constructed so that the characteristics of the flow are utilized to facilitate removal of the reduced particles from the grinding chamber.

Further objects of the invention will be apparent as it is described in detail with the accompanying drawing, wherein:

Figure 1 is a side view of one form of the grinding device;

Figure 2 is a modification thereof wherein the device has a helical form; and

Figure 3 is a view in front elevation showing a modification of the device that is of oval form.

Referring to the above drawing, and particularly to the modification of this invention shown in Figure 1, a U-shaped tube 10 of substantially circular cross-section is provided with an axially disposed inlet conduit 13 secured on one end thereof, and an outlet pipe 14 leading to a suitable exhaust chamber. A material suspending fluid under pressure is introduced through the inlet conduit 13 by means of a nozzle 15 which is carried by the conduit 13. The suspending fluid is introduced into the grinding chamber 11 of the mill 10 through nozzle 15 by a supply pipe 16, the directional flow of the fluid stream being as indicated by the arrow in Figure 1.

The material to be reduced is introduced into the fluid stream by means of a nozzle 17, which is provided with a chamber 18 formed in conduit 13 immediately in advance of the nozzle 15. A hopper 19 communicates with chamber 18 and thus supplies material to the jet issuing from nozzle 17, entraining the material in the fluid stream and directing it into nozzle 15. The material suspended in the fluid stream is directed into the grinding chamber 11 at a pressure greater than that in the said chamber, whereupon the fluid stream flows through the chamber under the flow conditions described above.

It will be observed that since the centrifugal force of the heavier particles is greater than that of the smaller or more reduced particles the tendency of the larger particles to be entrained in the entraining medium will be less pronounced than that of the smaller particles and the former will tend to remain adjacent the outer wall of the curved tube. As the larger particles are reduced by attrition, they will gradually become more subject to the characteristic flow of the suspending fluid by reason of its viscosity. When the par-

ticle size has been sufficiently reduced the effect of centrifugal force is overcome sufficiently to permit entrainment of the particles in the fluid stream to such extent that the double helical flow of the fluid stream exercises a selective control thereover, carrying the entrained particles to a point adjacent the inner portion of the tubular chamber wall, the larger particles remaining in the outer portion of the tube. It will thus be observed that the characteristic flow of the suspending fluid in the curved tubular portion of the mill is utilized as a means of selecting the finely reduced particles from the mass, carrying them to the inner periphery of the grinding chamber during operation of the mill.

Advantage is taken of this condition to improve the uniformity of collection by providing an outlet pipe **20** at the inner periphery of the curved tubular wall for removing the said particles, said outlet pipe **20** communicating with a suitable collecting device. Insufficiently reduced particles in the curved grinding chamber are maintained away from the outlet **20** by centrifugal force and are discharged with the suspending fluid through outlet pipe **14**, where they may be collected in any suitable collecting device for subsequent reprocessing, if desired.

In one preferred embodiment of the invention, outlet **20** is located on the inner periphery of the curve and lies at an angle to the axis of the tube and in a direction generally reverse to the direction of flow through the tube. This formation further avoids collection of over-sized particles.

In the structure shown in Figure 2, the present invention is embodied in an annular ring formation, the material to be reduced being introduced into the annular ring **22** thereof by means of a nozzle **21** which may be similar to the corresponding element of the structure described in Figure 1. An annular grinding chamber **22***a* is provided with an outlet **23** positioned on the inner wall of the grinding chamber at a point remotely situated from inlet pipe **21**, in the direction of the fluid flow, thus fully utilizing the reducing effect of the double helical flow produced in the mill chamber before exhausting the concentration of reduced particles from the inner wall thereof. As described in connection with the embodiment of the invention shown in Figure 1, outlet **23** is preferably angularly disposed in relation to the inner wall of the chamber in the opposite direction to that of the fluid flow, thus avoiding undesirable collection of insufficiently reduced particles and accumulations of reduced particles therein.

It will be noted that as the centrifugal force of the larger particles is greater than that of the reduced particles, the former tend to remain near the outer periphery of the curved section **22** of the mill, and thus escape discharge until sufficiently reduced to be entrained in the double helical flow of the suspending medium. Those particles which are unreduced during their first revolution through the grinding chamber remain in the device, being carried over for further treatment until sufficiently reduced to be entrained in the fluid flow.

In the structure shown in Figure 3, the reducing mechanism is shown as assuming an elliptical form, consisting of a straight entrance tube **24** which may be supplied with material to be reduced through a hopper **25**, the material entraining means being otherwise similar in contsruction to the corresponding elements shown in Figures 1 and 2. The straight section **24** communicates with curved end section **26** which in turn connects with a straight section **27** and curved end section **28**. The latter communicates with straight section **24** through straight section **29**. Reduced particles are exhausted from the mill through outlet pipe **31** located on the inner wall of curved section **28**, being positioned remotely from the inlet pipe **24** in the direction of the fluid flow, so as to fully utilize the reducing action of the characteristic flow produced in the curved tubular portion of the device before exhausting the material from the mill. Outlet **31** is disposed at an acute angle in relation to the inner wall of section **28** in a direction opposite to that of the fluid flow, in a manner similar to the outlet structures shown in Figures 1 and 2. In operation it is preferred that this mill be supported so that it lies in a vertical plane.

It will thus be seen that the present invention provides an effective means of increasing the efficiency of grinding mechanisms utilizing a characteristic double helical flow as a means of reducing the particles by attrition. The present invention also provides means allowing continued operation of such grinding apparatus, with simultaneous introduction of untreated material into the grinding chamber and withdrawal of the reduced product being possible. Furthermore, by exhausting the reduced particles at a point adjacent the inner periphery of the curved tubular grinding chamber, the accumulation of reduced material thereon is utilized with a resulting uniformity of product heretofore unachieved in the art.

While the present invention has been described with reference to specific structural elements of this invention, it is obvious that such details are included only for purposes of illustration and that the scope of the invention is not to be limited save as defined in the appended claims.

I claim:

1. In apparatus for reducing material, the combination of a tube of substantially circular cross-section having at least one curved portion therein and a total curvature of at least 180°, means for supplying fluid to the tube for entraining and conveying material therein, and discharge means positioned substantially on the inner curved portion of the tube and extending angularly therefrom in a direction opposite that of the fluid flow, for exhausting reduced material therefrom.

2. In apparatus for reducing material, the combination of a tube of substantially circular cross-section having at least one curved portion therein and a total curvature of at least 180°, means for supplying a fluid to the tube for entraining and conveying material therein, and discharge means on the inner curved portion of the tube, positioned at less than a 90° angle to the axial tangent of the tube and extending in a direction reverse to that of the fluid flow, for exhausting reduced material therefrom.

3. In apparatus for reducing material, the combination of a tube of substantially circular cross-section having at least one curved portion therein and a total curvature of at least 180°, means for supplying a fluid to the tube for entraining and conveying material therein, and discharge means on the inner curved portion of the tube, positioned at less than a 90° angle to the axial tangent of the tube and extending in a direction reverse to that of the fluid flow, being positioned remotely of the said means in the direction of

the fluid flow, for continually removing reduced material from the inner periphery of the said tube.

4. In apparatus for reducing material, the combination of an endless elongated tube of substantially circular cross-section being disposed about a common axis to form a substantially closed circuit, means for supplying a fluid to the tube for entraining and conveying the material therein, and discharge means positioned substantially on the inner wall of the tube and extending angularly therefrom in a direction reverse to that of the fluid flow, being positioned remotely of the said means in the direction of the fluid flow, for exhausting reduced material therefrom.

5. In apparatus for reducing material, the combination of an endless elongated tube of substantially circular cross-section being disposed about a common axis to form a substantially closed circuit, means for supplying a fluid to the tube for entraining and conveying material therein, and discharge means positioned on the inner curved portion of the tube at less than a 90° angle to the axial tangent of the tube and extending in a direction reverse to that of the fluid flow, for continually removing reduced material from the inner periphery of the said tube.

6. In apparatus for reducing material, the combination of an endless tube of substantially circular cross-section having a number of curved portions in the length thereof, the said curved portions being connected to form a substantially closed circuit, means for supplying a fluid to the tube for entraining and conveying material therein, and discharge means positioned substantially on the inner wall of one of the said curved portions and extending angularly therefrom in a direction reverse to that of the fluid flow for exhausting reduced material therefrom.

7. In apparatus for reducing material, the combination of an endless tube of substantially circular cross-section having at least two curved portions in the length thereof, the said curved portions being connected by substantially straight portions to form a closed circuit, means for supplying a fluid to the tube for entraining and conveying material therein, and discharge means positioned substantially on the inner wall of one of the said curved portions remote in the direction of flow of the fluid from said means for supplying fluid and extending angularly therefrom in a direction reverse to that of the fluid flow, whereby reduced material is continually exhausted from the apparatus.

8. In apparatus for reducing material, the combination of an endless tube of substantially circular cross-section having at least two curved portions in the length thereof, the said curved portions being connected by substantially straight portions to form a closed circuit, means for supplying a fluid to the tube for entraining and conveying the material therein, and discharge means positioned substantially on the inner wall of one of the said curved portions and being at less than a 90° angle to the axial tangent of the said curved portion of the tube and extending in a direction reverse to that of the fluid flow, whereby reduced material is continually exhausted from the apparatus.

CLEO HAROLD KIDWELL.